



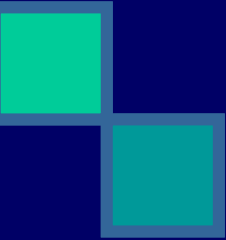

Introduction to webKORIGEN and Applications within NUCLEONICA



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Introduction

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- webKORIGEN is based based on the Karlsruhe Isotope Generation and Depletion Code KORIGEN and was developed from the ORNL-Code ORIGEN 2
 - From the initial amount and composition of a nuclear fuel and a given irradiation history it determines the fuel nuclide inventory changed by neutron interactions and decays; the generation of daughters of the initial actinides and of fission products is calculated
 - Accounted n-interactions: (n,f) , (n,γ) , $(n,2n)$, $(n,3n)$
 - Decays: α , β^- , β^+ , internal transitions
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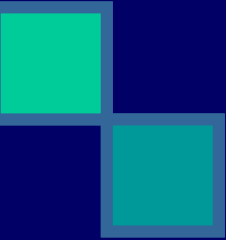



Development of KORIGEN and webKORIGEN

- KORIGEN : Author from 1975
 - webKORIGEN : Author, A. Schwenk-Ferrero (KIT), J. Galy (ITU), R. Dreher (ITU), J. Magill (ITU)
 - webKORIGEN is still being developed; R. Dreher's new strategy and with it the modified KORIGEN have to be implemented in NUCLEONICA.net
 - webKORIGEN exists also in a stand-alone version generating EXCEL tables of results for visualization
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webKORIGEN Objectives

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- Follow-up nuclide and element generation in a neutron field (reactor, irradiation facility) or during decay of a single nuclide; calculate subsequent decay including reprocessing
 - Allow easy input preparation by restriction to basic applications
 - Arrange output tables according to amount of masses, activities,...,toxicities (top-up)
 - Visualize results (graphs, chart of inventory nuclides)
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Nuclear Data

- Decay data (half-lives, branchings) from NUTAB97, dose conversion ICRP68, heat conversion factors (MeV/decay)
 - Fission product yields JEF-2
 - PWR/BWR UOX/MOX cross-sections for typical German power reactors
 - Fast reactor cross-sections European Fast Reactor (EFR)
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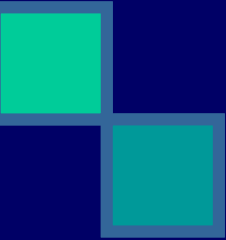



Calculated Quantities for Nuclides and chemical Elements

- Concentrations (mols, g)
 - Radioactivities (Bq)
 - Total and γ -heat releases (W)
 - Radiotoxicities for inhalation and ingestion (Sv)
 - Neutron and γ emission rates (1/s)
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Calculated Quantities (new)

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- Totals of chemical elements subgroups :
actinides, transurania, minor actinides,
lanthanides, rare earths, noble metals, inert
gases, hydrogen
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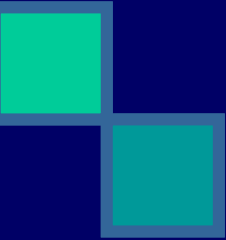



Easy Input preparation : Operation in Modes

- Mode 1: Power irradiation history given and time dependent neutron flux is derived, or a constant given neutron flux is used (target irradiation); only concentrations
 - Mode 2: Decay of a given nuclide
 - Mode 3: Power irradiation as in 1 but subsequent decay added; output provided for decay only
 - Mode 4: As in 3 but reprocessing and decay of waste is added; output provided for decay before and after reprocessing
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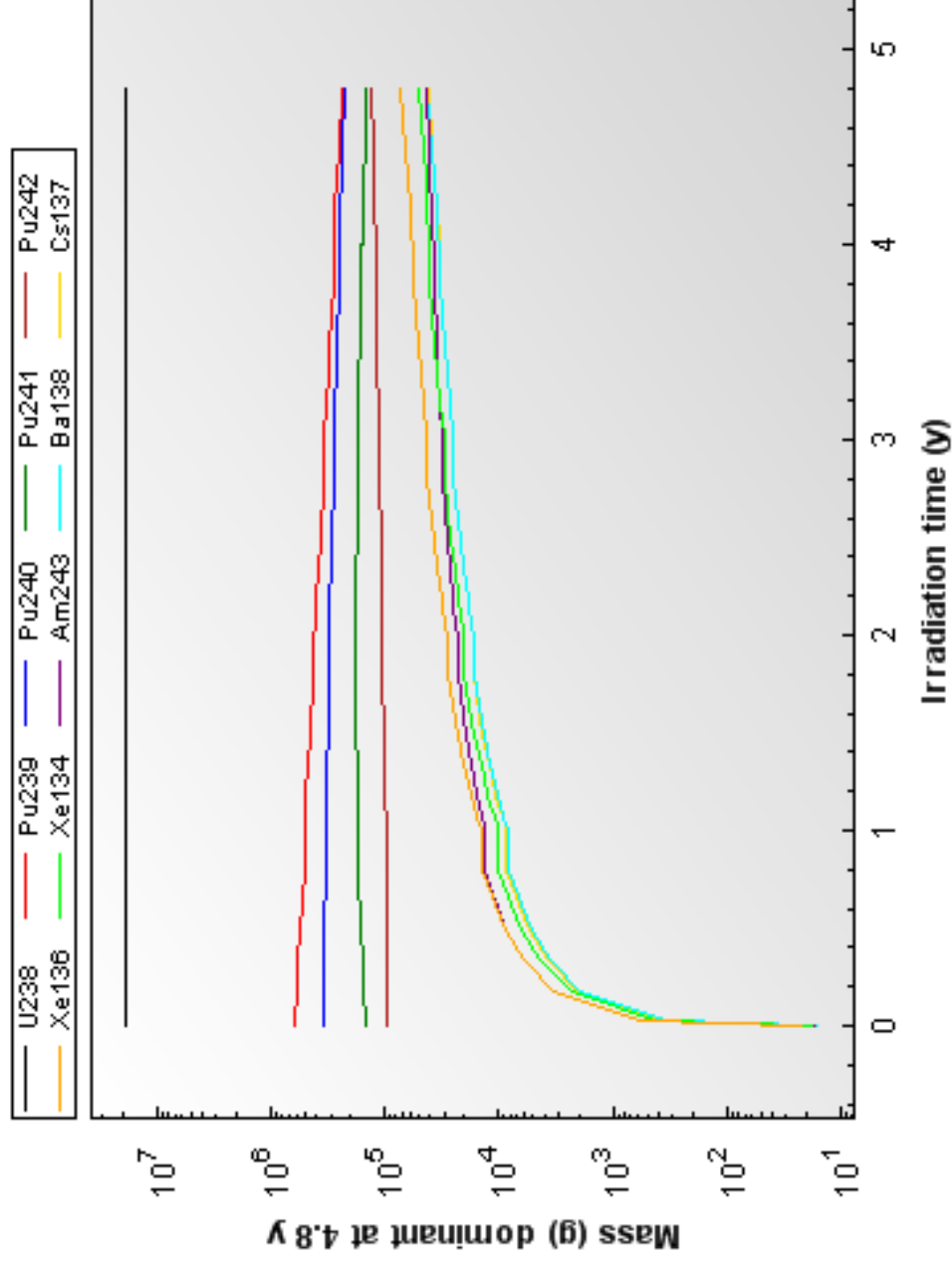
Irradiation History

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- For maintaining criticality, power reactors are operated in cycles of ca. 1y length; discharge burnup of 50 – 60MWd/kgHM after 5 – 6 cycles
 - During equilibrium operation at the end of each cycle fuel subassemblies with discharge burnup are unloaded and replaced by fresh S/U
 - In webKORIGEN power irradiation is specified by burnup, cycle length, number of cycles
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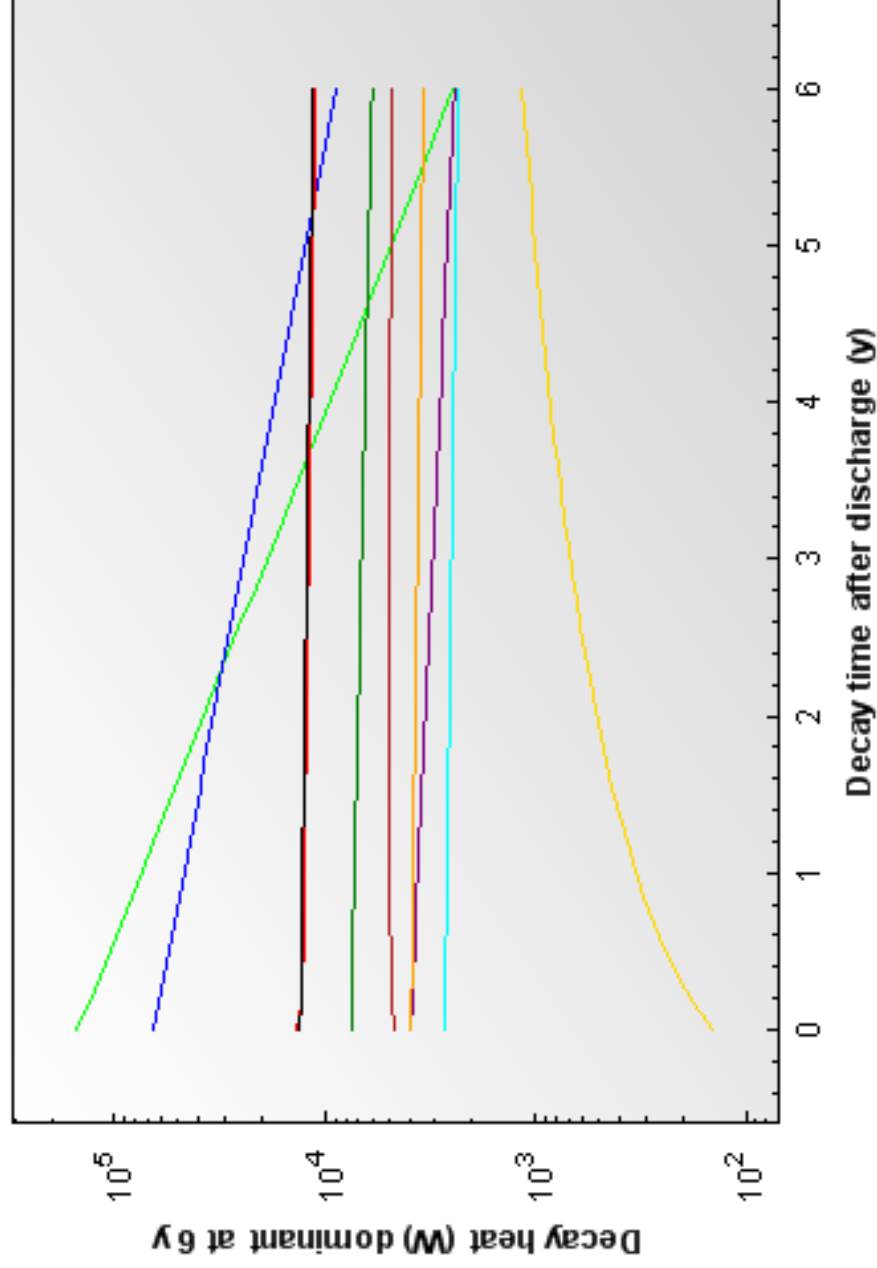
In the following some typical diagrams of results
will be shown which were generated with
NUCLEONICA webKORIGEN

Then several hands-on applications will be run

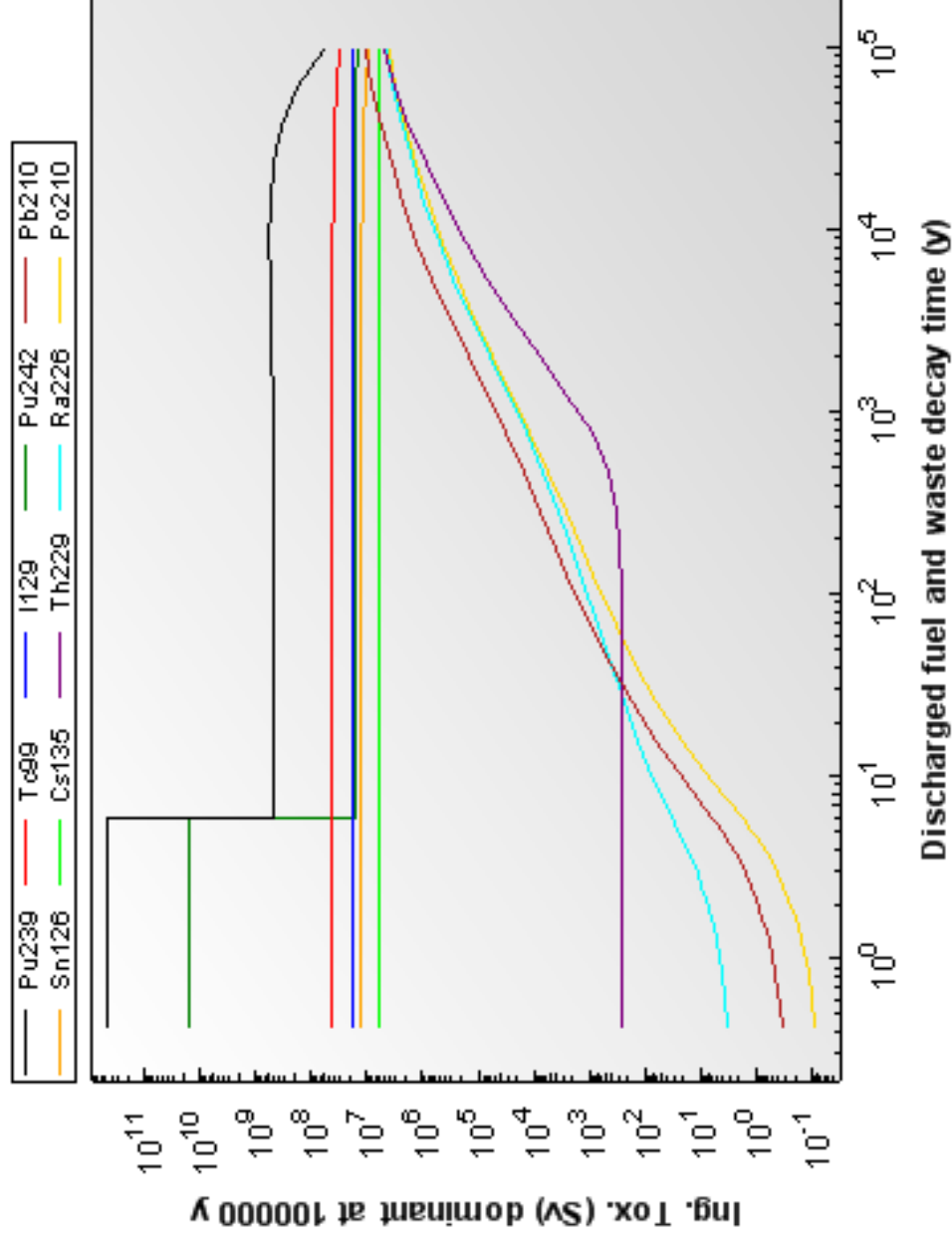
Nuclides during 4.8 y irradi. of 20 tHM PWR MOX



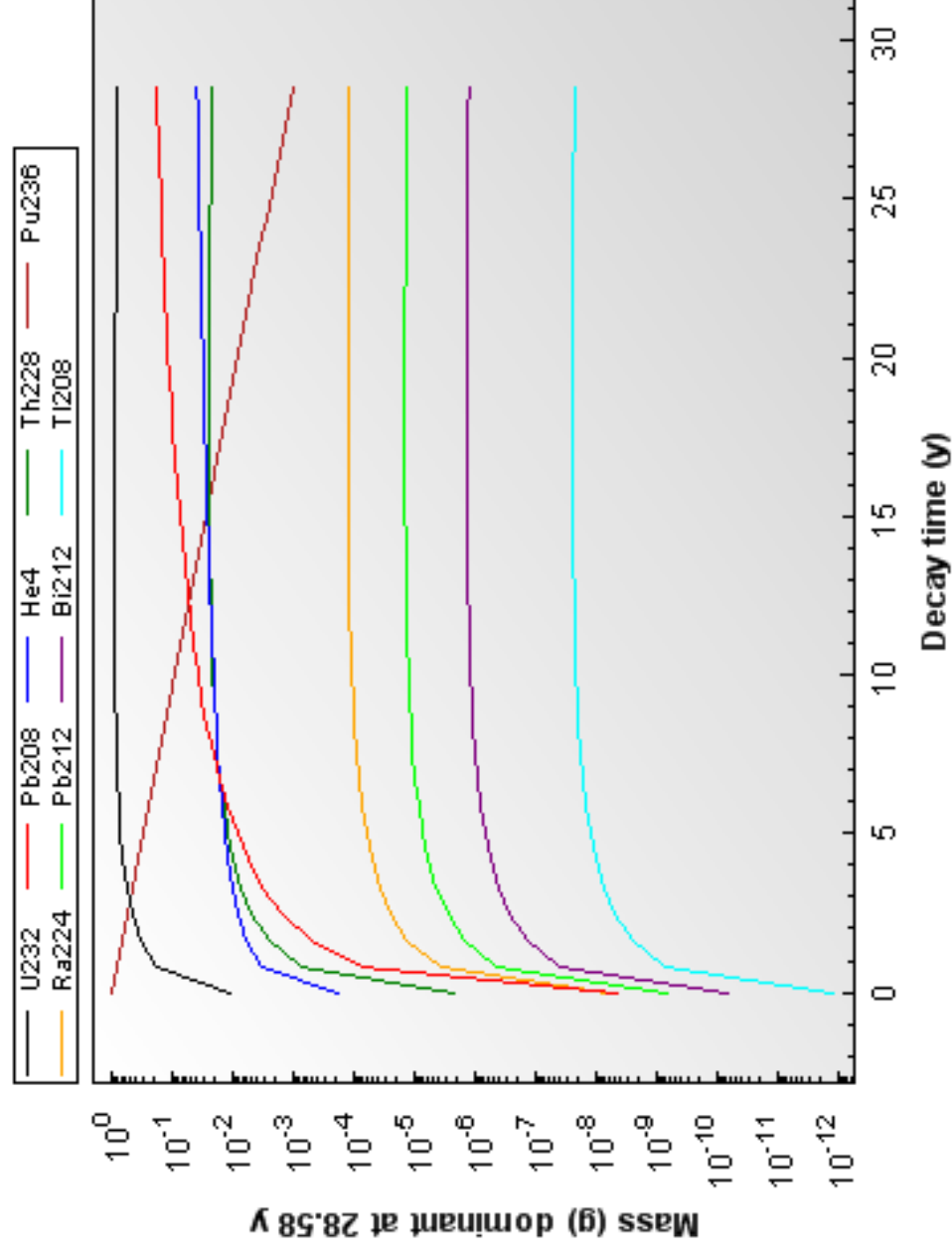
Nuclides during 6 y decay of 20 tHM PWR UOX 55 MWd/kg



Nuclides during 100000 y decay of 20 tHM PWR MOX 55 MWd/kg



Nuclides during 28.58 y decay of 1 g Pu236





To be done

- Extension to calculations for activation products and minor actinides transmutation
 - Provision of additional cross-section libraries e.g. for high-burnup fuels, HTRs, Gen IV reactors etc.
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